

Designation of Types for the New Diatom (Bacillariophyta) Taxa Described by Robert Hagelstein from Puerto Rico

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A total of 10 holotypes are identified, and 30 lectotypes and 2 isotypes are designated for the names of the taxa described by Robert Hagelstein in his work on diatoms from Puerto Rico. Marine, estuarine and freshwater taxa are included in this treatment. The groups are mostly raphid forms, with only one centric species being described as new. Illustrations and an emended description are provided for *Pinnularia laterittata* var. *minor*, which was not illustrated in the original publication. Transfer of Hagelstein's collection from the New York Botanical Garden (NYBG) to the Diatom Collection of the California Academy of Sciences (CAS) has required designation of CAS numbers, and they are listed along with Hagelstein's numbers for the type slides.

Robert Hagelstein had diverse interests, being not only a successful businessman, but also someone who published scientific works on diatoms (1939) as well as slime molds (1944). He amassed a diverse collection of diatom slides and samples, including the large collection of D.B. Ward, as well as a variety of associated manuscripts, illustrations and photographs from a variety of well- and lesser-known diatomists. He was a regular correspondent with contemporaries such as Charles Boyer and Albert Mann, with whom he exchanged slides, material and ideas. His collection was originally deposited at the New York Botanical Garden (Burke 1940), but just last year it was given to the Diatom Collection of the California Academy of Sciences (CAS).

Hagelstein's only published contribution was on the diatoms from Puerto Rico. In that work, he described 42 new taxa (25 new species and 17 new varieties), while making 1 new combination (*Caloneis disticha* (A. Schmidt) Hagelstein, comb. nov., basionym: *Navicula disticha*) and proposing 1 new name (*Navicula borinquensis* Hagelstein, based on the basionym *Navicula notanda* Østrup). While all of his new taxa are validly published (according to the International Code of Botanical Nomenclature-Greuter et al. 2000), he did not indicate in his manuscript the slides he used to base his descriptions, nor did he designate type slides for his new taxa. This is the same situation encountered by Simonsen relative to the Friedrich Hustedt collection, and the result in that case was the 3 volume set composed of a catalogue and illustrations of Hustedt's types (Simonsen 1987). The present contribution attempts to make explicit the slides Hagelstein used to base his descriptions and to designate type slides for the new taxa, but not to illustrate again the new taxa.

To best understand Hagelstein's approach and method, a large card file kept by him for his floristic project on the diatoms of Puerto Rico was reviewed. The file is organized by taxon, and has his notes on valve morphology, descriptions and notes as to which slides (and at which locations on the slides) he identified diatom taxa. This card file was extremely helpful to sort out where Hagelstein saw taxa, what his concept of the taxon was, and where specimens might be found.

Unfortunately, the file does not indicate exact locality information for the slides or samples, thus it is difficult to near impossible to match up the locality information listed in Hagelstein's manuscript with the existing samples. Matching up specimens to those presented as photographs in his 1939 work was difficult since the images were cut out along the margins, so as to leave out any other context for the specimens. However, in most cases, matching up specimens to those present in the 1939 work was done without too much trouble, since Hagelstein indicated which of the specimens he used for illustrations in his flora, by the abbreviation "Fig." associated with the location of the specimen.

I have followed Simonsen's (1987) approach to typification. In his work on Hustedt's types, Simonsen designated holotypes only in the instances where there were marked specimens on a single slide. When there are no such marked specimens, or when more than a single slide with marked specimens was encountered, Simonsen, designated lectotypes. In the case of the Hagelstein Collection, instead of searching for marked slides, his notes were used as guides to relate the specimens and slides.

The present report lists the new taxa described by Hagelstein, including the page number and plate and figure number for each new taxon. Habitats listed by Hagelstein where the taxon was found in his study are then followed by comments related to the slide(s) where specimens were found, designation of type slides, and in a few cases taxonomic status. All types are deposited at the Diatom Collection of the California Academy of Sciences (San Francisco), and provided herein are the new CAS slide numbers.

RESULTS AND DISCUSSION

Amphora bigibba var. *capitata*, Hagelstein, page 325/Pl. 3, fig. 7

HABITAT: Naval dock, San Juan Bay; Harbor of Christiansted, St. Croix

COMMENTS: Hagelstein's notes indicate he viewed specimens on slide 94D3 only. Observations in the context of the present report support Hagelstein's, and the specimen indicated as the type in his notes is present on 94D3. This slide is here designated as the lectotype.

Caloneis liber var. *incerta*, Hagelstein, page 336/Pl. 4, fig. 2

HABITAT: San Juan Bay

COMMENTS: Hagelstein's notes indicate he saw a single specimen of this new variety on slide 94D3. This individual specimen is present on the slide, the same one photographed and presented by Hagelstein. Slide 94D3 is the holotype for this taxon.

Campylodiscus cordatus, Hagelstein, page 337/Pl. 4, fig. 3

HABITAT: San Juan Bay

COMMENTS: Hagelstein encountered this new species of *Campylodiscus* in a large number of slides, including 91B1, 95A1, 117A2, 117B1, 118B1, 128B1, and 128B4. Presence of this species in each of these slides is confirmed. A single specimen on slide 118B1 was photographed and presented by Hagelstein, and this slide is here designated as the lectotype for the name of this species.

Cocconeis singularis, Hagelstein, page 343/Pl. 4, figs 7, 8

HABITAT: Ponce

COMMENTS: A single valve of this taxon was observed by Hagelstein on slide 73B1. Its presence is confirmed on that slide, which is the holotype.

Cyclotella insolita, Hagelstein, page 345/Pl. 4, fig. 9

HABITAT: Canal de Martin Peña

COMMENTS: Hagelstein's notes indicate this colonial *Cyclotella* is present on slides 165-2 and 165-3. It is easily found on both slides, which are of plankton. Slide 165-3 is here designated as the lectotype and slide 165-2 as an isotype for this species.

Cymbella coamoensis, Hagelstein, 347/Pl. 4, fig. 11

HABITAT: Coamo Springs

COMMENTS: A specimen conforming to the description of Hagelstein was found on slide 57A1. His illustration is of an initial valve, while his notes indicate this specimen is "perfect". The specimen photographed could not be located, therefore slide 57A1 is here designated as the lectotype for the name of this species.

Diploneis gravelleana, Hagelstein, 352/Pl. 5, fig. 2

HABITAT: San Juan Bay and adjoining marshes

COMMENTS: This species is present on Hagelstein slide 29B1, as indicated in his notes. It is here designated as the lectotype.

Diploneis smithii var. *adversa*, Hagelstein, 354/Pl. 5, fig. 3

HABITAT: Harbor of Christiansted, St. Croix

COMMENTS: Numerous specimens are present on Hagelstein slide 149-2A. This slide is here designated as the lectotype.

Eunotia indica var. *undulata*, Hagelstein, 357/Pl. 5, fig. 4

HABITAT: Near Carolina

COMMENTS: A single specimen was found on Hagelstein slide 228D1, as indicated in his notes. The slide is here designated as the lectotype.

Eunotia lunaris var. *duolineata*, Hagelstein, 357/Pl. 5, fig. 5

HABITAT: spring near Hato Rey

COMMENTS: Numerous specimens are found on Hagelstein slide 23A4, which is here designated as the lectotype. The acute "knick" on the ventral margin is the diagnostic feature of this taxon, according to Hagelstein's notes.

Gomphonema carolinense, Hagelstein, page 360/Pl. 5, fig. 6

HABITAT: Rio Grande de Loiza at Trujillo Alto; Carolina; pools on the sandy plain adjacent to Carolina

COMMENTS: A specimen conforming to the description and illustration in Hagelstein for this taxon was found on slide 143A1, which is here designated as the lectotype. It is surprising that in her consideration of this species, Patrick (in Patrick and Reimer 1975) did not consult Hagelstein's type. The image offered by Krammer and Lange-Bertalot (1991, plate 87, figure 12) of this taxon from an unknown locality appears quite different from Hagelstein's taxon, particularly in the shape of the valve and the organization of the central striae. Further research may suggest the two are not conspecific.

Gyrosigma acuminatum var. *angulatum*, Hagelstein, 365/Pl. 5, fig. 7

HABITAT: Quintana Spring

COMMENTS: Several specimens of this new variety were found on Hagelstein slide 248-2B1, including the specimen included in Hagelstein's publication. Slide 248-2B1 is here designated as the lectotype.

Gyrosigma variipunctatum, Hagelstein, 367/Pl. 5, fig. 8

HABITAT: Quarantine Station, San Juan Bay

COMMENTS: The specimen photographed by Hagelstein is present on slide 203A-1; his notes indicate it is known from a single specimen. Slide 203A-1 is the holotype.

Gyrosigma variistriatum, Hagelstein, 367/Pl. 5, fig. 9

HABITAT: Quarantine Station, San Juan Bay

COMMENTS: The single specimen presented by Hagelstein is present on slide 115B2. His notes indicate this new *Gyrosigma* is known from a single specimen only. Hagelstein slide 115B2 is the holotype.

Homeocladia vidovichii var. *nodulosa*, Hagelstein, 369/Pl. 5, fig. 11

HABITAT: San Juan Bay; Fajardo; Mayaguez

COMMENTS: This diatom is listed in Hagelstein's notes as occurring on slides 18C1 and 106B1, and as common on the latter slide. The two specimens observed on 18C1 did not match the illustration on plate 5. We have not been able to match any one of the literally hundreds of specimens on 106B1, but it seems safe to suggest it should serve as the lectotype for this new variety. Thus, slide 106B1 is here designated as the lectotype.

Mastogloia obliqua, Hagelstein, 375/Pl. 5, figs 12, 13

HABITAT: Fajardo

COMMENTS: Hagelstein indicates this taxon is present on a single slide, 230C1, in the Hagelstein collection. This slide is the holotype of this species.

Mastogloia sancti-johannis, Hagelstein, 376/Pl. 6, fig. 1

HABITAT: Naval Dock, San Juan Bay

COMMENTS: The specimen illustrated by Hagelstein was found on slide 91B2, and this slide is here designated as the lectotype.

Navicula congerana, Hagelstein, 382/Pl. 6, figs 8, 9

HABITAT: Mangrove marsh at Miramar

COMMENTS: Hagelstein's notes indicate he saw this new species on two slides, 116A3 and 116B1, and that the figures were of specimens from slide 116B1. Observations from this study confirm the presence of this new *Navicula* on both slides, and that the specimens illustrated by Hagelstein are on slide 116B1, which is here designated as the lectotype for this taxon.

Navicula expansa, Hagelstein, 384/Pl. 6, fig. 10

HABITAT: Canal de Martin Peña

COMMENTS: A population of this new *Navicula* species occurs only on Hagelstein slide 31A, and it is the holotype.

Navicula guaynaboensis, Hagelstein, 385/Pl. 6, fig. 11

HABITAT: near Guaynabo

COMMENTS: The specimen illustrated by Hagelstein may be found on slide 138B1, and this slide is here designated as the lectotype for this taxon.

Navicula howeana, Hagelstein, 385/Pl. 7, fig. 1

HABITAT: Harbor of Christiansted, St. Croix

COMMENTS: No card for this taxon was found in Hagelstein's file, and no other written materials related to the taxon have been uncovered. Slides from the locality indicated by Hagelstein have yielded no specimens. With the apparent loss of the original specimens, the illustration pro-

vided by Hagelstein is here designated as the lectotype, in accordance with the provision of Article 9.2 of the International Code of Botanical Nomenclature (Greuter et al. 2000), which states "A lectotype is a specimen or illustration designated from the original material as the nomenclatural type . . ."

Navicula incomposita. Hagelstein, 386/Pl. 7, fig. 2

HABITAT: Park Loiza; Laguna San José

COMMENTS: Hagelstein's notes indicate he observed this diatom from a variety of samples and slides, including 10B2, 83B2, 112A, 112B, 113A, 113B, 204, 217B1 and 217B2. The specimen illustrated is present on slide 112A1 and this slide is here designated as the lectotype. Slide 112A6 appears to be an isotype.

Navicula incomposita var. *minor*. Hagelstein, 386/Pl. 7, fig. 3

HABITAT: Park Loiza; Santa Isabel; San Juan marshes

COMMENTS: According to Hagelstein's notes, this new variety was observed on the following slides: 82B1, 255A1, and 255C1. While many more specimens are indicated in the notes to have been seen on sample 255 slides, his notes indicate the specimen figured came from slide 82B1, which is here designated as the lectotype for this species.

Navicula lyra var. *irregularis*. Hagelstein, 388/Pl. 7, figs 5, 6

* HABITAT: San Juan Bay and marshes; Fajardo; Ponce

COMMENTS: The specimens illustrated in figures 5 and 6 on plate 7 were found on slide 115A1, which is here designated as the lectotype for this new variety.

Navicula mannii, Hagelstein, 388/Pl. 7, figs 7, 8

HABITAT: Quarantine Station; Fajardo; San Juan Bay

COMMENTS: Hagelstein lists two slides, 203B and 256B2, on which he identified this new variety. Though he indicates a single specimen on slide 256B2 "...seems to be [the] best specimen" the individual could not be found on the slide. The taxon is common on slide 203B and, coupled with its absence on slide 256B2, this recommends here designating slide 203B as the lectotype.

Navicula tubulosa var. *rhomboidea*. Hagelstein, 391/Pl. 7, fig. 13

HABITAT: San Juan Bay and marshes

COMMENTS: This new variety was identified by Hagelstein from two slides, 18C1 and 118B1, but only a single specimen was identified from the slides (from slide 18C1), and this single specimen did not match the illustration. While there is original material extant from which Hagelstein based his description, slide 18C1 is here designated as the lectotype of this new variety.

Nitzschia brittonii, Hagelstein, 393/Pl. 7, fig. 14

HABITAT: San Juan Bay and marshes

COMMENTS: No card for this Hagelstein was found. With the apparent loss of the original specimens, the illustration provided by Hagelstein is here designated as the lectotype, in accordance with the provision of Article 9.2 of the International Code of Botanical Nomenclature (Greuter et al. 2000).

Nitzschia hemistriata, new species, 396/Pl. 8, fig. 1

HABITAT: Canal de Martín Peña

COMMENTS: Hagelstein's notes suggest this new species can be found on two slides, 29B1 and 31B1, but he only showed a reference point for one of the slides. The specimen illustrated by

*common in freshwater

Hagelstein was found on slide 31B1, recommending this slide to be here designated as the lectotype.

Nitzschia miramarensis, Hagelstein, 398/Pl. 8, figs 4, 5

HABITAT: Marsh at Miramar

COMMENTS: On the single slide listed by Hagelstein to possess this taxon, the specimens illustrated by him were found. The slide, 116B1, is the holotype.

Nitzschia obtusa var. *lata*, Hagelstein, 399/Pl. 8, figs 6, 7

HABITAT: Mangrove marshes at San Juan

COMMENTS: Specimens were found on the following slides: 26A1, 29A1, 29B1, 164A1, 164B1, 164C25 and 164C26. Specimens illustrated by Hagelstein are to be found on slide 164A1, and it is here designated as the lectotype.

Nitzschia obtusa var. *undulata*, Hagelstein, 399/Pl. 8, figs 8, 9

HABITAT: Marshes at martine Peña; Santurce

COMMENTS: This taxon was found only on slide 220B1, which is here designated as the lectotype.

Nitzschia ponciensis, Hagelstein, 401/Pl. 8, fig. 13

HABITAT: Naval Dock at San Juan Bay; Ponce

COMMENTS: This species was found on a single slide, and one specimen on this slide corresponds to the one illustrated by Hagelstein. Slide 73B1 is the holotype slide.

Nitzschia quickiana, Hagelstein, 401/Pl. 8, fig. 14

HABITAT: Mangrove marsh at Miramar

COMMENTS: This species was found on slides 31B1 and 164B1. The figured specimen was found on 164B1, and this slide is here designated as the lectotype.

Pinnularia laterittata var. *minor*, Hagelstein, 407/not figured

COMMENTS: Hagelstein did not provide illustrations of this new variety in his original work. While lack of illustrations does not render this taxon invalid, since algae described prior to 1958 do not require illustrations for valid publication (Article 39.1, Greuter et al. 2000), figures and an emended description are provided herein.

EMENDED DESCRIPTION: Valves straight with slightly tumid middle and ends rounded, 98.0–126.0 μm long, 15.5–17.5 μm broad. Striae radiate, becoming parallel then convergent at the ends, longitudinal lines cross the striae about 1/3 the distance from the axial area to the margin, 7–8 striae in 10 μm . Raphe lateral, undulate, external distal raphe ends bayonet-shaped, helictoglossae distinct. Figures 1–8.

Hagelstein (p. 406) discusses the possible implications of *Pinnularia latevittata* Cleve and its varieties producing (in the current terminology) *cis* frustules, that is the orientation of features on each valve of a frustule in the same direction. A wide range of naviculoid diatoms had been known to only produce *trans* frustules, where the orientation of features of valves of a frustule is in opposite directions. In *P. laterittata* var. *minor*, both *cis* (figs 6–8) and *trans* (figs 1, 2) frustules were observed. This phenomenon of a single species producing both *cis* and *trans* valves, which occurs in other *Pinnularia* species, was described and analyzed by Mann (1983).

Slide 131A1 is here designated as the lectotype. Hagelstein reports this taxon from a several slides, including 57A1, 130B1, 143D1, 143D2, 145A1, 145A2 and 145B1.

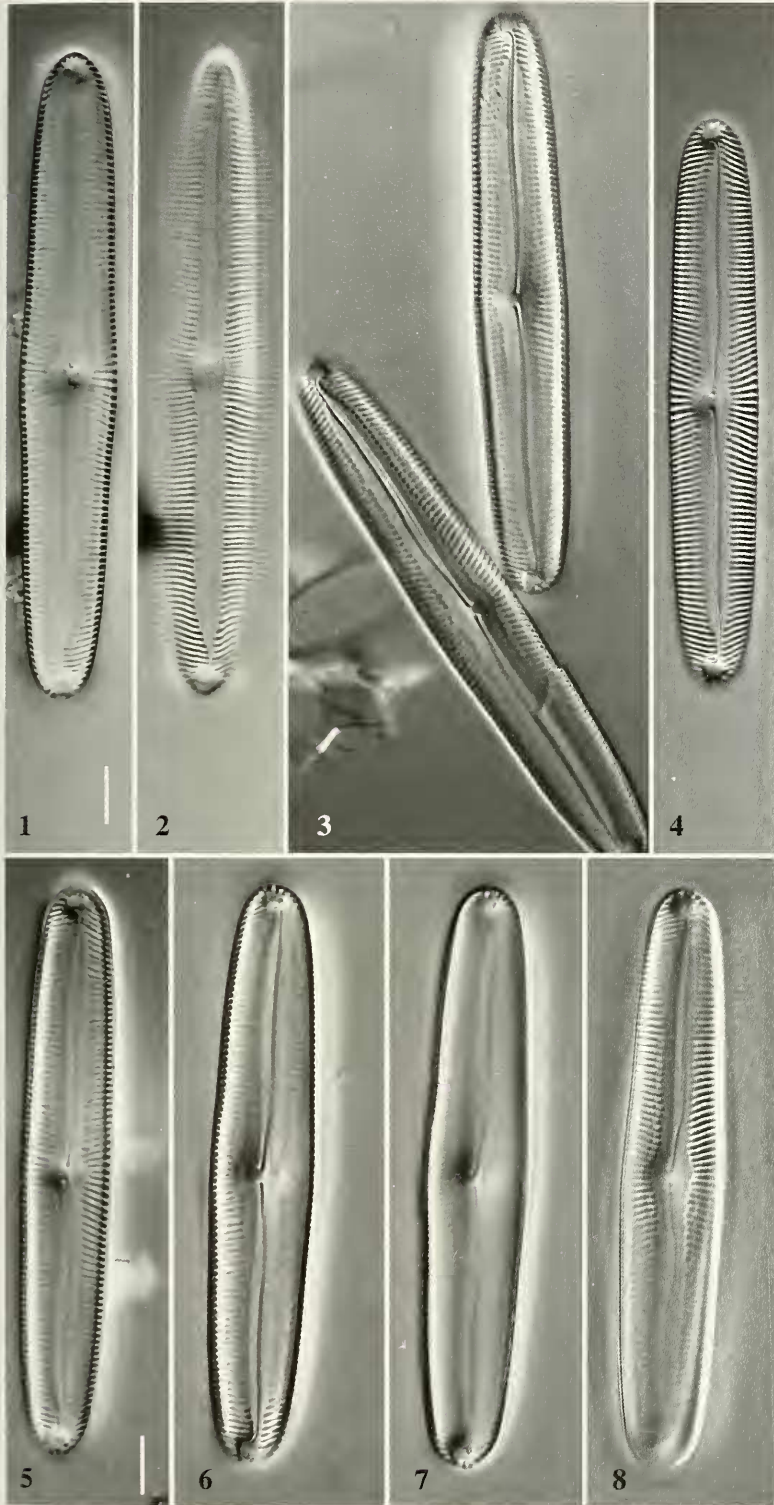


PLATE 1. Light microscopy. Figures 1-8. *Pinnularia laterittata* var. *minor* Hagelstein. Size range of this taxon is documented. Figures 1 and 2 are from the same frustule showing *trans* valves. Figs. 6-8 are of the same frustule, showing *cis* valves. Scale bar in figure 1=10 μ m, same for all figures.

Pinnularia titusiana, Hagelstein, 408/Pl. 9, figs 2, 3

HABITAT: common at Coamo Springs

COMMENTS: This species was identified from slides 52A1 and 170A, as indicated by Hagestein in his notes. The specimens figured by Hagelstein were found on slide 52A1, and it is here designated as the lectotype.

Pinnularia viridis var. *subconstricta*, Hagelstein, 409/Pl. 9, fig. 4

HABITAT: Coamo Springs; ditches south of Santurce

COMMENTS: Hagelstein indicated this new variety can be found on slides 52A1, 168, 170A and 174. The illustrated specimen was found on slide 52A1, and this slide is here designated as the lectotype.

Pleurosigma angusti-convexum, Hagelstein, 409/Pl. 9, fig. 5

HABITAT: Canal de Martin Peña

COMMENTS: This new *Pleurosigma* species was found only on slide 165-2 which is the holotype.

Pleurosigma portoricense, Hagelstein, 412/Pl. 9, figs 6, 7

HABITAT: Rio Grande de Loiza; pools on the sandy plain near Carolina

COMMENTS: This species was found on slides 143B3 and 226B1. The illustrated specimens were both found on slide 143B3, and it is here designated as the lectotype.

Pleurosigma strigosum var. *incisum*, Hagelstein, 414/Pl. 9, figs 8, 9

HABITAT: near Park Loiza

COMMENTS: This new variety was found on the only slide indicated in Hagelstein's notes, slide 110A1. This slide is the holotype.

Stauroneis similaris, Hagelstein, 421/Pl. 9, fig. 12

HABITAT: ditch near Park Loiza

COMMENTS: This specimen was found on slide 111A1, and it is here designated as the lectotype.

Trachyneis aspera var. *atomus*, Hagelstein, 428/Pl. 9, fig. 14

HABITAT: Harbor of Christianstedt, St. Croix

COMMENTS: Hagelstein's notes indicate that this new *Trachyneis* variety is to be found on slides 149-2A3 and 149-1B2. The specimens encountered on these slides do not appear to be the same as those illustrated in the publication, although Hagestein indicates in his notes the illustrated specimen should be on slide 149-2A3. Unlike the situation described by Kociolek and de Reviere (1996), where Manguin material from Lake Karluk had been lost, and therefore illustrations were designated as holotypes, we have located specimens used by Hagelstein to describe this variety. Slide 149-2A3 is here designated as the lectotype for this taxon.

Tropidoneis van-heurckii var. *maxima*, Hagelstein, 430/Pl. 9, fig. 15

HABITAT: marsh at Miramar

COMMENTS: This new variety occurs on slides 255A1 and 255C1. The specimen illustrated is found on slide 255A1, and it is here designated as the lectotype. Subsequent research on this taxon may find it to represent the larger end of the size diminution series of the nominate variety.

A summary of the typification of Hagelstein's taxa is provided in Table 1.

TABLE 1. Listing of original slide numbers, type status taxon, and new CAS number for each of the taxa described by Hagelstein.

Original Number	Type status	Taxon	CAS
94D3	Lectotype	<i>Amphora bigibba</i> var. <i>capitata</i>	221057
	Holotype	<i>Caloneis liber</i> var. <i>incerta</i>	
118B1	Lectotype	<i>Caupylodiscus cordatus</i>	221058
73B1	Holotype	<i>Cocconeis singularis</i>	221059
165-3	Lectotype	<i>Cyclotella insolita</i>	221060
165-2	Isotype	<i>Cyclotella insolita</i>	221061
	Holotype	<i>Pleurosigma angusti-convexum</i>	
57A1	Lectotype	<i>Cyubella coamoensis</i>	221062
29B1	Lectotype	<i>Diploneis gravelleana</i>	221063
149-2A	Lectotype	<i>Diploneis smithii</i> var. <i>adversa</i>	221064
228D1	Lectotype	<i>Eunotia indica</i> var. <i>undulata</i>	221065
23A4	Lectotype	<i>Eunotia lunaris</i> var. <i>duolineata</i>	221066
143A1	Lectotype	<i>Gomphonema carolinense</i>	221067
248-2B1	Lectotype	<i>Gyrosigma acuminatum</i> var. <i>angulatum</i>	221068
203A-1	Holotype	<i>Gyrosigma variipunctatum</i>	221069
115B2	Holotype	<i>Gyrosigma variistriatum</i>	221070
106B1	Lectotype	<i>Homeocladia vidovichii</i> var. <i>nodulosa</i>	221071
230C1	Holotype	<i>Mastogloia oblique</i>	221072
91B2	Lectotype	<i>Mastogloia sancti-johannis</i>	221073
116B1	Lectotype	<i>Navicula congerana</i>	221074
	Holotype	<i>Nitzschia mirauarensis</i>	
31A	Holotype	<i>Navicula expansa</i>	221075
138B1	Lectotype	<i>Navicula guaynaboensis</i>	221076
112A1	Lectotype	<i>Navicula incomposita</i>	221077
112A6	Isotype	<i>Navicula incomposita</i>	221078
82B1	Lectotype	<i>Navicula incomposita</i> var. <i>minor</i>	221079
115A1	Lectotype	<i>Navicula lyra</i> var. <i>irregularis</i>	221080
203B	Lectotype	<i>Navicula mannii</i>	221081
18C1	Lectotype	<i>Navicula tubulosa</i> var. <i>rhomboidea</i>	221082
31B1	Lectotype	<i>Nitzschia hemistriata</i>	221083
164A1	Lectotype	<i>Nitzschia obtusa</i> var. <i>lata</i>	221084
220B1	Lectotype	<i>Nitzschia obtusa</i> var. <i>undulata</i>	221085
73B1	Holotype	<i>Nitzschia ponciensis</i>	221086
164B1	Lectotype	<i>Nitzschia quickiana</i>	221087
131A	Lectotype	<i>Pinnularia laterinata</i> var. <i>minor</i>	221088
52A1	Lectotype	<i>Pinnularia titusiana</i>	221089
	Lectotype	<i>Pinnularia viridis</i> var. <i>subcoustricta</i>	
143B3	Lectotype	<i>Pleurosigma portoticense</i>	221090

TABLE 1 (continued). Listing of original slide numbers, type status taxon, and new CAS number for each of the taxa described by Hagelstein.

Original Number	Type status	Taxon	CAS
110A1	Holotype	<i>Pleurosigma strigosum</i> var. <i>incisum</i>	221091
111A1	Lectotype	<i>Stauroneis similaris</i>	221092
149-2A3	Lectotype	<i>Trachyneis aspera</i> var. <i>atomus</i>	221093
255A1	Lectotype	<i>Tropidoneis van-heurckii</i> var. <i>maxima</i>	221094

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LITERATURE CITED

- BURKE, J.F. 1940. The diatom collection at the New York Botanical Garden. *Journal of the New York Botanical Garden* 41:277-280.
- GREUTER, W., J. MCNEILL, F.R. BARRIE, M. BURDET, V. DEMOULIN, T.S. FILGUEIRAS, D.H. NICOLSON, P.C. SILVA, J.E. SKOG, P. TREHANE, N.J. TURLAND, AND D.L. HAWKSWORTH. 2000. *International Code of Botanical Nomenclature. Regnum Vegetabile* 138:1-474. O. Koeltz, Koenigstein.
- HAGELSTEIN, R. 1939. Diatomaceae. New York Academy of Sciences. Botany of Porto Rico and the Virgin Islands. Pages 313-450 in *Scientific Survey of Porto Rico and the Virgin Islands*, vol.VIII, part 3.
- HAGELSTEIN, R. 1944. *The Mycetozoa of North America*. 306p.
- KOCIOLEK, J.P., AND B. DE REVIERS. 1996. The diatom types of Emile Manguin. I. Validating descriptions and designation of iconotypes for the Lake Karluk species. *Cryptogamie:Algologie* 17:175-191.
- KRAMMER, K. and H. LANGE-BERTALOT. 1991. Bacillariophyceae. 4. Achnanthaceae, Kritische Ergänzungen zu Navicula (Lineolatae) und Gomphonema Gesamtliteraturverzeichnis Teil 1-4. *Süßwasserflora von Mitteleuropa*. Gustave Fisher. Stuttgart. 437 p.
- MANN D.G. 1983. Symmetry and cell division in raphid diatoms. *Annals of Botany* 52: 573-581.
- PATRICK, R.M., AND C.W. REIMER. 1975. *The Diatoms of the United States*, Vol. II, Part 1. Monograph No. 13. Academy of Natural Sciences of Philadelphia. 213 p.
- SIMOSNEN, R. 1987. *Atlas and Catalogue of the Diatom types of Friedrich Hustedt*. 3 Volumes. J. Cramer, Berlin.